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## EX/P8-07: Global Mode Control and Stabilization for Disruption Avoidance in High-Beta NSTX Plasmas

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Global MHD instabilities may disrupt operation of ITER and other future tokamaks. The National Spherical Torus Experiment (NSTX) has previously investigated passive stabilization and demonstrated active control of resistive wall modes (RWMs), accessing high  $\beta_N = 7.2$ . Current research focuses on greater understanding of the stabilization physics, projection to future devices, quantitative comparison to experiment, and demonstration of improved active control techniques that can aid the goal of disruption avoidance in ITER. Combined radial and poloidal field sensor feedback gain and phase used in NSTX experiments produced a greater than three times reduction in disruption probability. Time domain analysis with the VALEN code reproduces the dynamics of the mode amplitude as a function of feedback phase and determines the optimal gain. Additionally, a new model-based RWM state space controller proposed for ITER, which includes a 3D model that compensates for plasma and mode-induced wall currents, was used. Open-loop comparisons between sensor measurements and the state space control model showed agreement with a sufficient number of states and when details of the 3D wall model were added. The state space controller was demonstrated to sustain long pulse, high  $\beta_N$  discharges, and reduce  $n = 1$  applied fields that normally disrupt the plasma. Present calculations of kinetic stability using the MISK code show improved quantitative agreement with NSTX experimental marginal stability points and emphasize the importance of the plasma rotation profile. Collisions have competing effects: they both dissipate the mode energy and damp the stabilizing kinetic effects. The low collisionality of future machines can improve RWM stability, but only if the plasma rotation is in a favorable resonance. Energetic particles have been shown to be generally stabilizing, and scaling of the model to ITER high performance discharges indicates that the stabilizing effects of alpha particles may be required to maintain a stable RWM at the expected plasma rotation profile. Alterations to the theory now focus on improved agreement with experiment over the entire database. One such alteration is the inclusion of anisotropic distribution functions for energetic particles from neutral beam injection.

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